Technical Manual

AP GPS Navigators MK8/MK9/MK9DC

- Installation
- Interface
- Trouble Shooting
- Maintenance
- Technical data
- International Service
- Special Features
- Waypoint Lists

Leica Geosystems A/S
AP Navigation Business Unit
February 1998 3508 101 87993

Specifications may be changed without prior notice.

Leica

Please note

The prudent mariner will never rely solely on any single means of navigation. He will always use whatever information available.

The Global Positioning System (GPS) is developed and operated by the United States Department of Defense (DOD).

Only part of the system is available for civil applications. The expected position accuracy is better than 100 meters for 95 percent of the time; but may be up to 300 meters occasionally. The derived speed and course readings may be hampered accordingly.

The availability and precision will be kept within the stated limits as far as the military and political situation allows.

Differential GPS (DGPS)

The MK8 and MK9 are prepared for direct connection to a DGPS Beacon Receiver (Philips PBR 1000). The MK8 will for this purpose need a DGPS software upgrade and a new interface cable allowing data input. The position accuracy is hereby improved to better than 5 meters for 95% of the time subject to availability of DGPS transmissions from public Radio Beacons.

Please note that a position obtained from a chart is not always as accurate as your navigator, and that the position of a floating aid can differ due to tide and set and drift. In addition the DGPS system may be hampered by weather conditions such as heavy rain, snow or thunder storms.

Leica Geosystems A/S
AP Navigation Business Unit
Hørkær 12A
DK-2730 Herlev
Denmark Printed in Denmark

Contents

Installation

The MK8 & MK9 Navigators are designed for installation both above and below deck. The unit is fully splash proof but not watertight. The installation should in the first instance meet the requirements of the helmsman or the crew, but secondarily the site should be a smooth and flat nearly vertical surface to insure that the gasket around the holes for connection plugs and fixing screws are waterproof. Please ensure that the navigator is mounted in a place where water easily flows off. Never install it in a place where the navigator will be below water for any period of time. Two installation accessories are optionally **available: A** Flush Mounting Kit and a Mounting Bracket (please see the chapter containing technical data page 27).

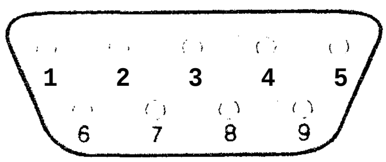
Backup Battery

Insert the battery cell in the battery compartment on the back of the navigator. Please refer to the instruction on page 21.

Connectors

The navigator has two connectors. **A** D-SUB **(A)** for power and data and a F-connector **(B)** for the antenna *signal:*

A. 9 pin D-SUB (male)



9POL D SUB

Pin No.

1	REF GND. Reference for MOB signal. Connected to navigator shield.
2	NMEA listener **A** (input).
3	NMEA talker **A** (output).
4	MOB (Man Over Board) signal.
5	battery. **External** power.
6	Programming voltage. For service use only.
7	NMEA listener B (input).
8	NMEA talker B (output).
9	+ battery. External power.
Screen	Shield of NMEA talker cable.

B. F (RUG59) connector. RF signal from antenna. **Stripping** information:

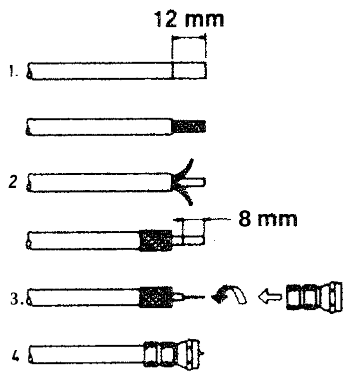


Figure 1

1. Strip the antenna cable.
2. Fold **back** the shield.
3. Screw the F connector on.
4. The center conductor **should** peep out 2 **Po** 3 mm from the connector nut.

A typical installation is shown on the next page figure 2.

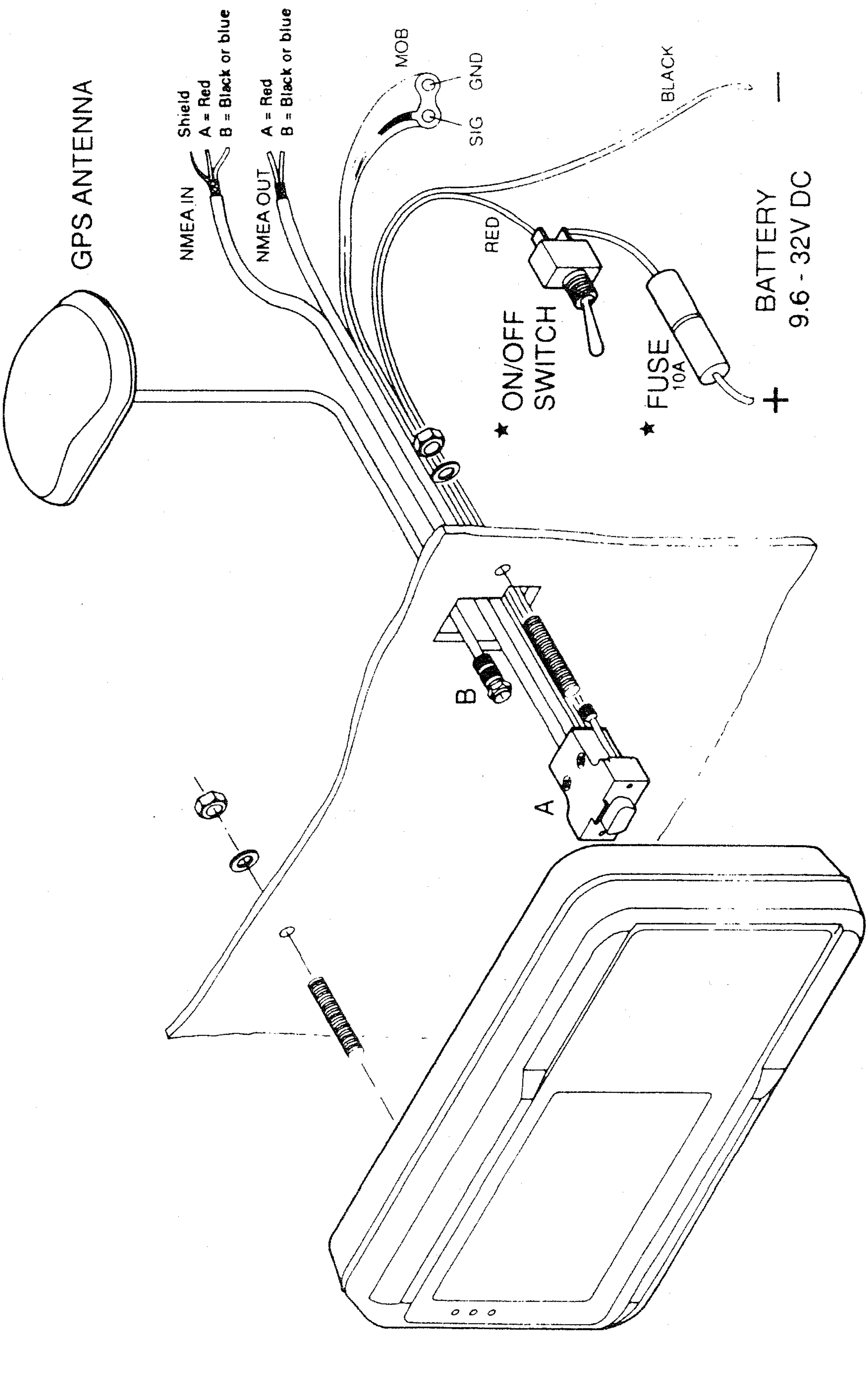


Figure 2.

*) Power switch and fuse are not included in the installation **kit.** The fuse can be any value from 1.25 Amp to 10 Amp.
The NMEA IN and MOB cables are not included in the MK8 standard package.

Drilling Instruction.

A template is included in the installation kit. Place the 'Drilling Template for MK8 & MK9' where you want your unit installed. Be sure that you have access to back side for tightening the nuts.

Recommended tools for installation.

Toots:	Use:
* Adjustable spanner	To tighten the nuts.
* Drill 13mm	Hole for antenna mounting.
* Drill 9mm	Holes for D-SUB connector.
* Drill 7mm	Holes for mounting stays.
* Electric power drill	
* Hand file	To smooth the hole for the 5-SUB connector

External Power.

The navigator is designed for 12V or 24V battery supply, but the unit will work with any DC voltage from 9.6V to 32V.
The installation kit includes a 9 socket D-SUB connector mounted with all the necessary cabling. The Power Cable is a joint RED and BLACK pair:

BLACK wire (D-SUB socket 5) should be connected to the minus pole of the battery.
RE5 wire (D-SUB socket 9) should be connected to the plus pole of the battery.

Please be sure to have a fuse in the circuit - not to protect the navigator - but to protect the cabling. (Short-circuiting a cable with direct connection to a battery will make severe damage). A typical installation is shown in figure 2 page 5.

Navigator grounding.

The electronics of the navigator is isolated from the external power supply. It is recommended to ground the shield of the navigator to avoid static charge built up. This can be done in one of two ways:

1)Connect the D-SUB 'GND' pin 1 of the navigator to boat's seawater ground.
2)Connect the antenna mounting (nut etc.) to the boat's seawater ground.

'Seawater ground' is any structure in connection with the sea below the water-line. The connection could be through a 10 KOhm resistor.

Antenna mounting and navigator shield is electrically connected through the screen of the antenna cable. To avoid current loops do only use one of the two grounding methods. If the antenna is mounted on the push pit or similar metal structure we recommend using that part for grounding of the navigator (possibly by connecting it to boat's seawater ground).

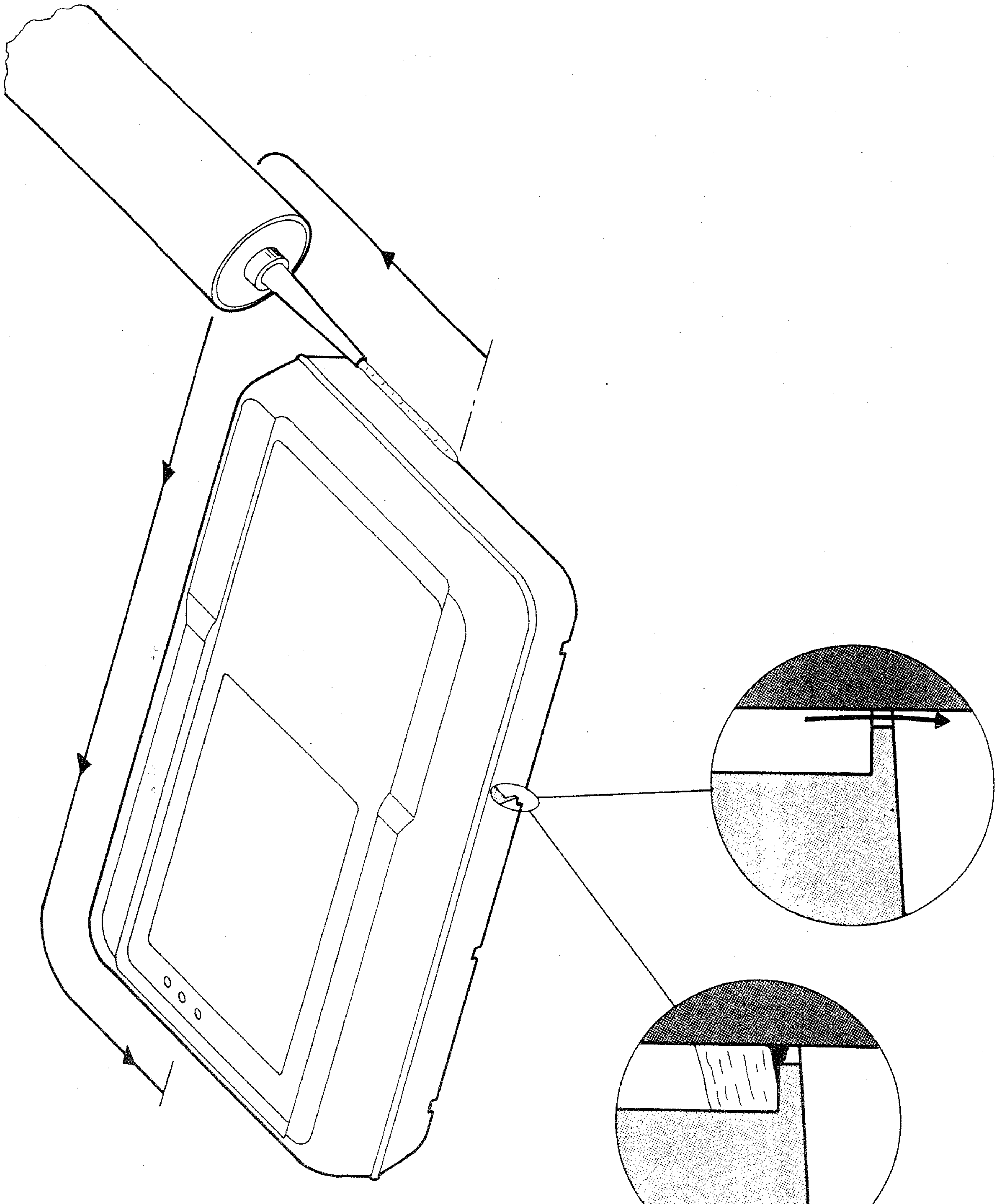


Figure 3. Above deck bulkhead installation.

Interface to other equipment.

The MK8 and MK9 navigators have two independent possible interfaces. A Man Over Board input and an NMEA 0183 version 2.0 talker/listener interface.

Man Over Board

A push button foran on/off switch) (optional) can be connected between the Man Over Board input (D-SUB pin 4) and the REF GND (D-SUB pin 1).

The installation kit includes a 9 socket D-SUB connector mounted with all the necessary cabling. The Man Over Board is either a joint BLACK pair with one wire marked with an embossment or a joint GRAY pair with one wire marked with a black stripe.

> The pair should be connected to a push button that is normally off (not short-circuited). To enable the Man Over Board function the switch must be activated for at least 2 seconds.

Please be aware, that the unmarked wire of this pair is connected to the shield of the navigator. A typical installation is shown in figure 2 page 5. See also figure 4 below if using the Philips NMEA 0183 Repeater Display for the Man Over Board function.

NMEA interface

The standard marine interface NMEA 0183 version 2.0 is used for communication with other marine equipment like:

Radars, Plotters, Autopilots, Fish Finders etc.
Philips NMEA 0183 Repeater Display
Philips Chart Plotters PCP 207 and PCP 211
Philips DGPS Beacon Receiver PBR 1000
DGPS Beacon Receivers transmitting RTCM SC104 data (4800 baud).

NMEA interface to other equipments

There should be no problem in interfacing to other instruments. Version 2.0 of the NMEA 0183 interface has been changed in several ways compared to the earlier version 1.5. Same *of* the changes to the hardware **should be** mentioned in order *to* avoid problems.

Listener:
The listener input now works with a threshold of 2 volt cornpared to the former 4 volt. It is still an isolated input and in general it should not give any problems.

Talker:
The talker output is now a RS422 output. That means:
NMEA talker (output) B is active compared to GND or shield of the navigator. In the old version output B was normally tied to GND or shield.
The maximum drive voltage between NMEA talker A and B outputs is ±6 volt. The minus voltage between the talker A and B output might give some problems on inputs that does not fulfill the old standard
The minimum voltage might be as low as ±2 volt. This is not compatible with the former 4 volt input threshold.

Cables used for NMEA signals are shielded. If extension cables are needed be sure to use shielded cables in order to avoid electromagnetic noise

More than one **NMEA** listener can be connected in parallel to the NMEA talker. The possible maximum is dependent on the listener input impedance. **A typical installation is shown in figure 4.**

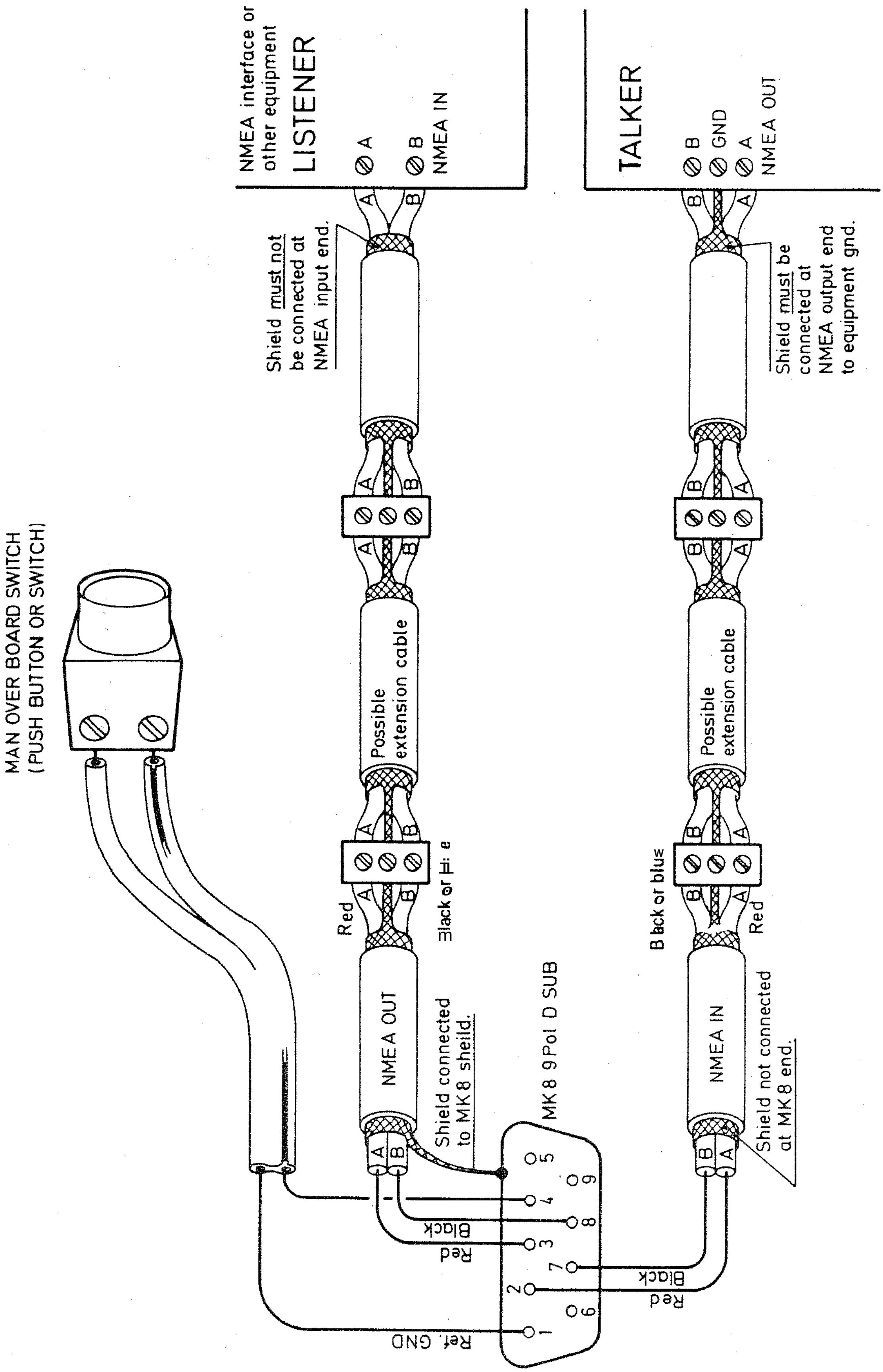


Figure 4. NMEA and MOB installation for the MK9 unit.

Interface to Philips NMEA 0183 Repeater Display.

The Philips NMEA 0183 Repeater Display should be connected to the navigator MK9 as shown in figure 5. (Connections are specified on page 4).

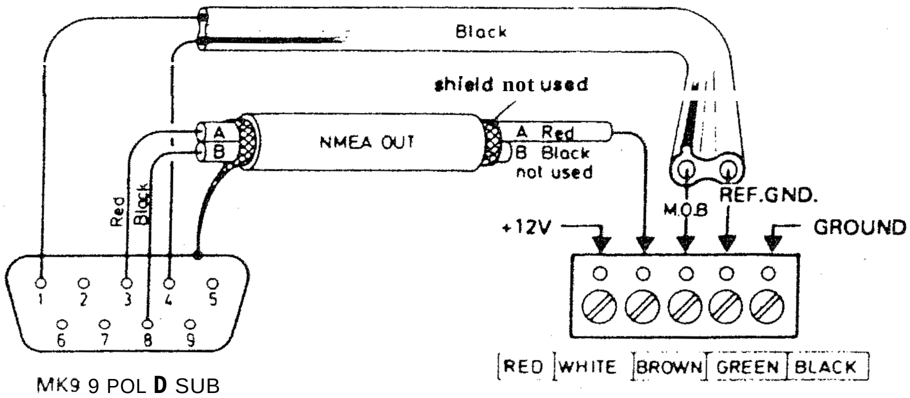


Figure 5

Please note
NMEA talker (output) B should **not** be connected to the Repeater Display but left open.
The shield of the NMEA talker cable is connected to shield of the navigator and should **not** be connected to the Repeater Display.
Be **careful** that neither the **NMEA talker** B wire nor **the shield** of the NMEA talker cable are short-circuited to each other or anything else.

NMEA 0183 version 2.0 hardware schematics.

The **NMEA** version 2.0 standard requires that a schematic showing the implementation of the listener and talker interface are included in the manual.

NMEA listener (input) hardware schematic and recommendations.

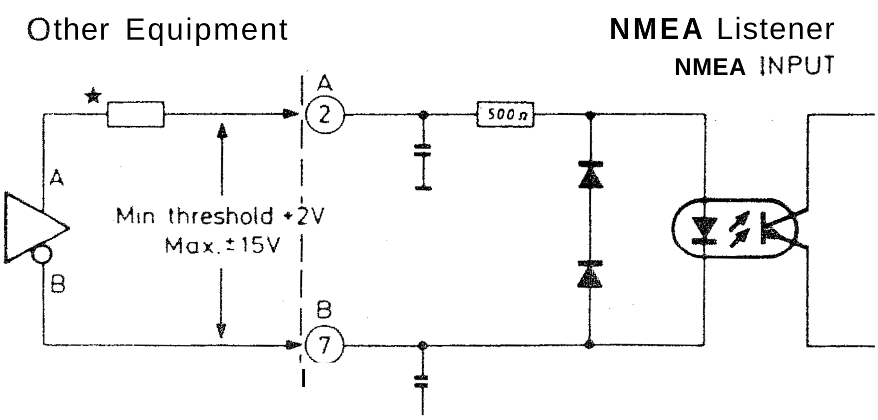


Figure 6 Listener input load 500ohm.

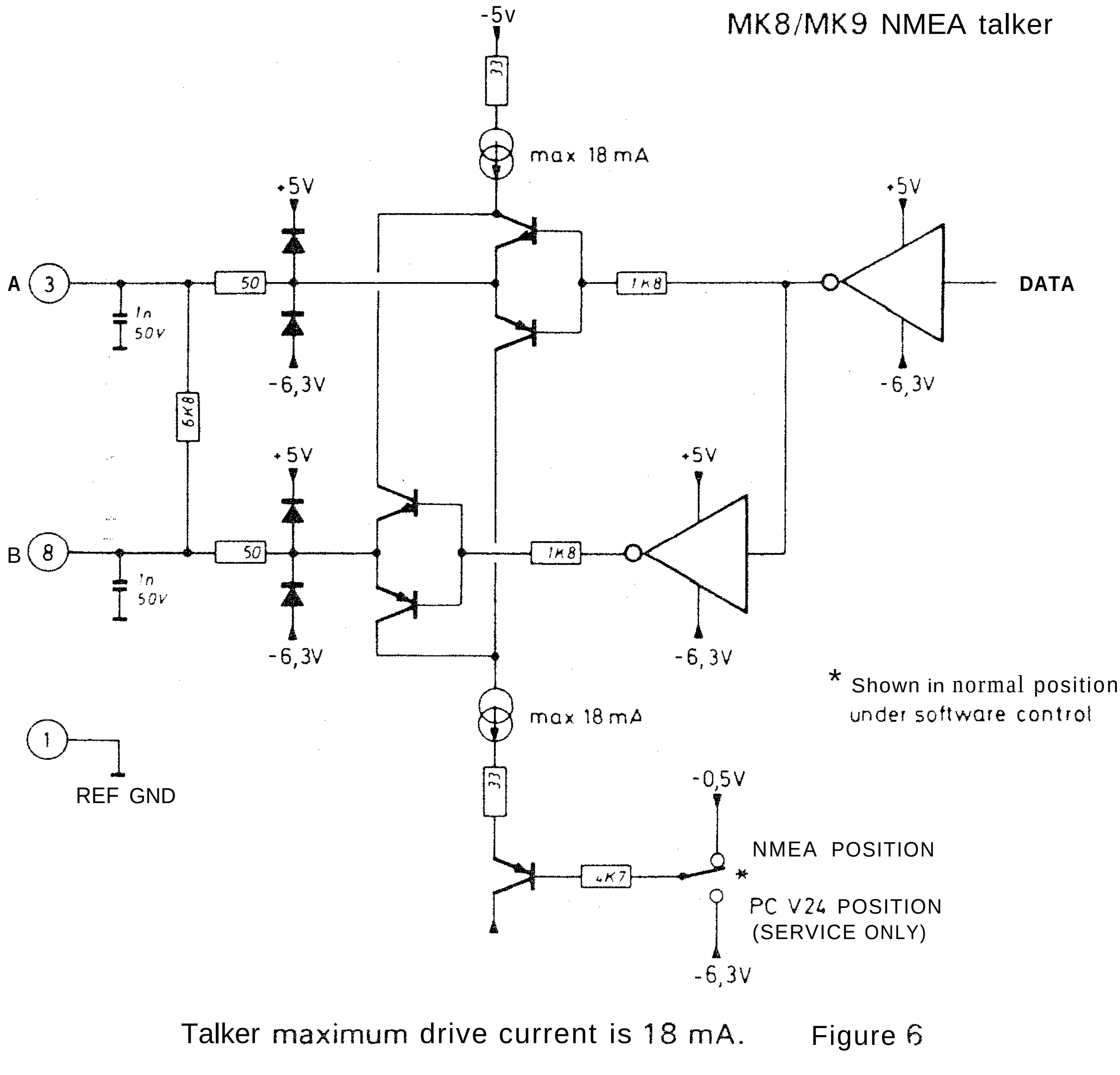
The threshold of the MK8/MK9 NMEA listener is less than 2V. If an external NMEA output with a drive voltage higher than 2 volt is connected to the MK8/MK9 NMEA listener (D-SUB pin 2 and 7), it is recommended to insert a resistor in the line. The value could be up to 500ohm per volt the drive voltage exceeds 2 volt. This will reduce the overall power consumption.
See table 1 next page.

The MK8/MK9 NMEA listener (A to B) is rated to withstand ± 15 volt. If no resistor is inserted the NMEA input draws 22 mA at ± 12 volt where only 2 mA is needed for correct functionality.

Recommended external serial resistor value (see figure 6 previous page) for the MK8/MK9 **NMEA** listener interface. Table **1**:

Drive voltage	Resistor value	Drive voltage	Resistor value
3 volt	470 Ohm	8 volt	2.7 KOhm
4 volt	1.0 KOhm	9 volt	3.3 KOhm
5 volt	1.5 KOhm	10 volt	3.9 KOhm
6 volt	1.8 KOhm	11 volt	3.9 KOhm
7 volt	2.2 KOhm	12 volt	4.7 KOhm

NMEA talker (output) hardware schematic and recommendations.



Talker maximum drive current is 18 mA. Figure 6

Important: Both talker **A** and talker B outputs are active!
Connected to an NMEA listener: Connect talker **A** to listener A and talker **B** to listener B.
Connected to a RS 422 port: Connect talker **A** to +receive and talker B to -receive.
Connected to a RS 232 (PC com port): Connect talker ***A*** to Receive Data and REF GND to Signal Ground.

NMEA 0183 sentences Used by MK8 and MK9

The NMEA Standard provides for asynchronous transmission, with a single TALKER and multiple LISTENERs per line. Typical use includes information transfer from electronic positioning and navigational devices to autopilots, plotters, terminals, printers, etc.

The NMEA 0183 Standard uses an 8 **bit** ASCII **block** oriented protocol, that **is** not compatible *with* the NMEA 0780 simple format or the NMEA 0182 complex format due to differences in data format, baud rate and parity bit.

The recommended interconnection between a TALKER and one or more LISTENER(s) must **be** made as shown and described on the previous **4** pages.

Data Format.

Data are transmitted in different sentences, each containing one or more data fields. **A** field consists of a string of characters immediately preceded **by** a "," (comma) character, except for the first (address) which is preceded by "$". Hex OD **OA** <CR> <LF> - end of sentence - must follow the last fieid in each sentence.

The data fields are identified only by their position within the sentence as determined by the field delimiters (comma). Numerical data fields within a sentence may vary in length from one sentence to another, depending on the precision available.

Data field position **is** therefore determined only by counting "," (commas) rather than counting the total number of characters from beginning of the sentence.

Example:

```
field #   2          3  4           5  6
$ GPRMC, 5541.62, N, 01236 07, E * xx <CR><LF>
| |____|  |_____|  |  |_______|  |  |  |_| |_______|
| |       |        |  |          |  |  |   |
| |       |        |  |          |  |  |   |___ Sentence terminator
| |       |        |  |          |  |  |_____ Optional checksum
| |       |        |  |          |  |          (HEX), not data field
| |       |        |  |          |  |_____ Checksum delimiter
| |       |        |  |          |_____ East
| |       |        |  |_____ Longitude 12°36.07
| |       |        |_____ North
| |       |_____ Latitude 55°41.62
| |_____ Address
|        GP = TALKER identifier GPS
|        GLL = Sentence formatter  Geographic Latitude and Longitude
|_____ Start of sentence delimiter
```

NMEA sentences TRANSMITTED from the MK8/MK9 navigators:

The sentences all have the TALKER identifier "GP"

All GPS determined position data are in the user selected datum; waypoint positions reflect the content of the waypoint memory.

Please note:
RMB is transmitted only if a SAILPLAN is present.
APA, APB, and **XTE**, are transmitted only if a SAILPLAN is present and the AUTOPILOT ALARM is enabled and this alarm is in no alarm condition.

ACCORDING TO NMEA 0183, VERSION 2.0 OF 1992, JANUARY 1, 1552.

RMC - Recommended Minimum Specific GPS data:
Time, date, position, course and speed data provided by the MK8/MK9 receiver. Checksum is mandatory in this sentence. This sentence is transmitted at intervals not exceeding 2 seconds, and is always accompanied **by** RMB when a destination waypoint **is** selected. **All** data fields must be provided, null fields used only when data are temporarily unavailable.

```
field: 2       3 4        5 6         7 8    9    10     11     12 13
$GPRMC,hhmmss,A,1111.111,a,yyyyy.yyy,a,xx.x,xxx,ddmmyy,xx.x,a*hh<CR><LF>
```

explanation:

2. UTC of position fix
3. Status **A** or **V, A** if updating is OK, V if updating is stopped
4. Latitude of fix
5. North or South, N/S
6. Longitude of fix
7. East or West, E/W
8. Speed over ground, Knots
9. Track made good (COG), degrees true
10. Date: Day, Month and Year
11. Magnetic variation, degrees
12. East or West, E/W
13. Checksum delimiter and checksum

RMB - Recommended Minimum Navigation Information:
Navigation data from present position to the first destination waypoint in the sailplan. This sentence always accompanies the RMC, when a destination waypoint **is** selected. Checksum is mandatory in this sentence.

```
field: 2 3    4 5   6   7        8 9      10 11    12 13   15
$GPRMB,A,x.xx,a,ccc,ccc,11111,11,a,yyyy,yy,a,xxx.x,xxx,xx.x,*hh<CR><LF>
```

explanation:

2. Status **A** or V, **A** if updating is OK, V if updating is stopped
3. Magnitude of cross-track-error, nautical miles (see Note 1)
4. Direction to steer, L or R
5. Origin waypoint identifier
6. Destination waypoint identifier
7. Destination waypoint latitude
8. North or South, N/S
9. Destination waypoint longitude
10. East or West, E/W
11. Range to destination waypoint. nautical miles (see Note 2)
12. Bearing to destination, degrees true
13. Destination closing velocity, knots
14. Not transmitted from the MK8
15. Checksum delimiter and checksum

Note 1: if the XTE exceeds 9.99 **Nm,** 9.99 will be sent
Note 2: if the range exceeds 999.9 Nm, 999.9 will be sent

APB - Autopilot sentence "B"
Commonly used by autopilots, this sentence contains navigation receiver update status, cross-track error, initial bearing from origin waypoint to the next destination waypoint in the sailplan, continuous bearing from present position to destination and recommended heading to steer to destination waypoint for the active navigation leg of the sailplan. The sentence is transmitted when a **sailplan** has been created and the autopilot alarm is set to ON, and when this alarm is not in alarm condition.

```
field: 2 3 4    5 6    9  10 11  12 13 14 15
$GPAPB,A,A,x.xx,a,N,,,xxx,M,ccc,xxx,M,xxx,M<CR><LF>
```

explanation:

2. Status **A** or V, **A** if updating is OK, V if updating is stopped
3. not used, always **A**
4. Magnitude of XTE (cross-track-error)
5. Direction to steer, L or R
6. XTE units, N for nautical miles
7. and 8. not transmitted (empty fields)
9. Bearing origin to destination
10. Magnetic, M
11. Destination waypoint identifier
12. Bearing, present position to destination
13. Magnetic, M
14. Heading-to-steer to destination waypoint
15. Magnetic, M

BWC - Bearing & distance to Waypoint - Great Circle
BWR - Bearing & distance to Waypoint - Rhumb Line
Time (UTC) and distance & bearing to, and location of, the fist destination Waypoint in the sailplan from present position. Only one of the two sentences is transmitted, determined by the RL/GC selection in the SETUP function.

```
field: 2       3       4 5          6 7   8 9 1 0 1 1     12 13
$GPBWC,hhmmss,1111.11,a,yyyyy.yy,a,xxx,T,xxx,M,xxx.xx,N,ccc<CR><LF>
$GPBWR,hhmmss,1111.11,a,yyyyy.yy,a,xxx,T,xxx,M,xxx.xx,N,ccc<CR><LF>
```

explanation:

2. UTC of observation
3. Waypoint Latitude
4. North or South, N/S
5. Waypoint longitude
6. East or West, E/W
7. Bearing from present position to Waypoint
8. Degrees true, T
9. Bearing from present position to Waypoint
10. Degrees magnetic, M
11. Distance from present position to Waypoint
12. Nautical miles, N
13. Waypoint identifier

GGA - Global Positioning System Fix Data:
Time, position and fix related data for GPS receiver.
This sentence is available in MK8 with differential software and MK9 only.

```
Field: 1        2            3 4             5 6 7 8     9  10 11 12 13  14
$GPGGA,hhmmss,1111.1111,a,yyyyy.yyyy,a,x,x,xx.x,xxx,M,xxx,M,xxx,xxxx*hh<CR><LF>
```

explanation:

1. UTC of Position
2. GPS Latitude
3. Latitude.N or S
4. GPS Longitude
5. Longitude E or W
6. GPS Quality indicator QI (0=GPS not available or invalid, 1=GPS fix, 2=Differential GPS fix)
7. Number of GPS Satellites being used
8. Horizontal dilution of precision (HDOP)
9. Antenna height
10. Units of antenna height, meters
11. Geoidal Separation (the difference between the WGS 84 earth ellipsoid and mean-sea-level (geoid)
12. Units of geoidal separation, meters
13. Age of Differential GPS data
14. Differential reference station ID, 0000 - 1023

RTE - Routes
Waypoint identifiers, listed in order with starting waypoint first.
This sentence is available in MK9 only.

```
field: 2 3 4 5  6  7          8
$GPRTE,1,1,c,00,01,........,99*hh<CR><LF>
```

explanation:

2. Total number of messages being transmitted (always 1 (one))
3. Message number (always 1 (one))
4. **Message** mode: c =complete route, all waypoints
5. Route identifier (always 00)
6. Waypoint identifier
7. Additional waypoint identifiers
8. Waypoint 'n' identifier

VTG - Track Made Good and Ground Speed:
The actual track made good and speed over ground, COG and SOG.

```
field: 2   3 4   5 6    7 8   9
$GPVTG,xxx,T,xxx,M,xx.x,N,xx.x,K<CR><LF>
```

explanation:

2. Track degrees
3. True, T
4. Track degrees
5. Magnetic, M
6. Speed over ground
7. Knots, N
8. Speed over ground
9. Kilometres per hour, K

WPL - Waypoint Location:
Latitude and Longitude of specified waypoint
The content of ?his sentence will normally be the position of the next waypoint in the sailplan. When following the RTE sentence the positions of all the waypoints in the sailplan will be transmitted.

```
field: 2        3 4         5 6
$--WPL,1111.11,a,yyyyy.yy,a,ccc<CR><LF>
```

explanation:

2. Waypoint Latitude
3. North or South, N/S
4. Waypoint longitude
5. East or West, E/W
6. Waypoint identifier, 1 through 99

XTE - Cross-Track Error, Measured:
This sentence contains navigation receiver update status, magnitude of the position error perpendicular to the intended track Dine as determined by the sailplan, and the direction (Right/Left) to steer to reduce the error. The sentence is transmitted when the autopilot alarm is set to ON, and when this alarm is not in alarm condition.

```
field: 2 3 4    5 6
$GPXTE,A,A,x.xx,a,N<CR><LF>
```

explanation:

2. Status A or V, A if updating is OK, V if updating is stopped
3. not used, always A
4. Magnitude of XTE (cross-track-error)
5. Direction to steer, L or R
6. XTE units, N for nautical miles

ZTG - UTC and Time To Go to Waypoint
UTC and predicted time to go to destination waypoint.

```
Field: 2      3      4
$GPZTG,XXXXXX,XXXXXX,CCCC
```

2. UTC in Hour, Min and Sec
3. Estimated, Predicted or Elapsed Time En route
4. WPT or Point of Interest.

ACCORDING TO NMEA 0183, VERSION 1.5 OF DECEMBER 1987:

GLL - Geographic Position - Latitude and Longitude
Latitude and longitude of present vessel position.

```
field: 2         3 4          5
$GPGLL,llll.ll,a,yyyyy.yy,a<CR><LF>
```

explanation:

2. Latitude of present position
3. North or South, N/S
4. Longitude of present position
5. East or West, E/W

APA - Autopilot sentence "A":
Commonly used by autopilots, this sentence contains navigation receiver update status, cross-track error and initial bearing from origin waypoint to the next destination waypoint in the sailplan. The sentence is transmitted when the autopilot alarm is set to ON, and when this alarm is not in alarm condition.

```
field: 2 3 4    5 6    9  10 11
$GPAPA,A,A,x.xx,a,N,,,xxx,M,ccc<CR><LF>
```

explanation:

2. Status **A** or V, **A** if updating is OK, V if updating is stopped
3. not used, always **A**
4. Magnitude of XTE (cross-track-error)
5. Direction to steer, L or R
6. XTE units, N for nautical miles
7. and 8. not transmitted (empty fields)
9. Bearing origin to destination
10. Magnetic, M
11. Destination waypoint identifier

SNU - Receiver Update Status:

```
field: 2
$GPSNU,A<CR><LF>
```

explanation:

2. Status A or V, **A** if updating is OK, V if updating is stopped

Description of the NMEA sentence RECEIVED by the MK8 and MK9 navigators.

The navigator does not use the TALKER identifier, and any pair of characters within the NMEA specification are valid.

The navigator accepts floating format in the received numbers, and checksum is optional, but if applied, the navigator will reject any data contained in a sentence with erroneous checksum.

The received WPL data will overwrite the memory content of the waypoint location which is contained in the received WPL sentence.

WPL - Waypoint Location:
Latitude and longitude of specified waypoint

```
field: 2         3 4          5 6
$--WPL,1111.11,a.yyyyy.yy,a,ccc<CR><LF>
```

explanation:

2. Waypoint Latitude
3. North or South, N/S
4. Waypoint longitude
5. East or West, E/W
6. Waypoint identifier, 1 through 99

RTE - Routes
Waypoint identifiers, listed in order with starting waypoint first.
This sentence is received by MK9 only.

```
field: 2 3 4 5  6  7         8
$GPRTE,1,1,c,00,01,........,99*hh<CR><LF>
```

explanation:

2. Total number of messages being transmitted (always 1 (one))
3. Message number (always 1 (one))
4. Message mode: c = complete route, all waypoints
5. Route identifier (always 00)
6. Waypoint identifier
7. Additional waypoint identifiers
8. Waypoint 'n' identifier

Trouble Shooting Guide.

Please check your installation carefully before returning the navigator for service. A few hints are fisted in the table below. The navigator executes an online check of essential functions. If a function is found erroneous, the navigator gives an 'Internal Error' message every minute. To see the actual error code you must run the self test program in the SETUP function..

Problem	Likelv Cause	Action
No response: (Blank LCD display and no traffic light).	No external power supply.	Check battery voltage. Check for reverse polarity. Check wire installation. Check if fuse is blown.
Antenna open alarm.	Defect center core at antenna cable F connector.	Check that core of F connector is peeping out 1 mm. See figure 1.
Antenna short-circuit alarm.	Defect antenna cable installation.	Check antenna cable for hard bends and squeezing. Check if inner core is bent.
Battery low alarm.	Battery low.	Check battery voltage and installation.
Internal error.	Internal malfunction.	Return navigator for service. Please include error coae found.
No update: (Red blinking traffic light for more than 10 minutes).	Position or time is wrong. Back up battery is flat.	Make a power up reset: (Press E-key while power is switched on). Exchange backup battery (see page 21).

Table 2

Error codes

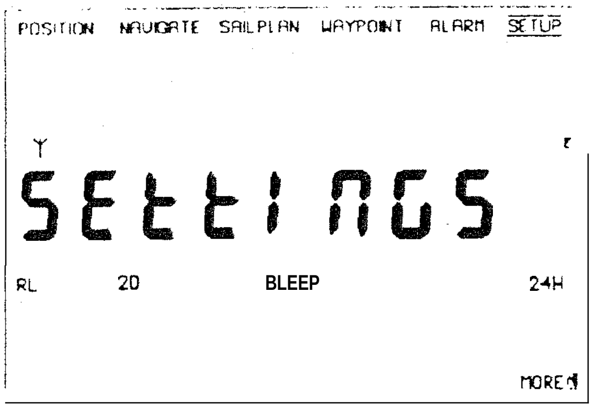
* Baseband related errors	100 to 109
* Real time clock errors	201 to 204
* E2ROM related errors	300 to 303
* Oscillator errors	400 to 410

If an error code is shown, please note it on a piece of paper and enclose it with the navigator when you send it in for repair.

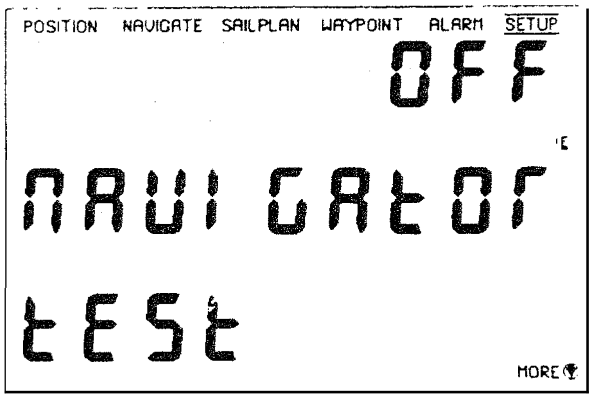
Navigator Self-test

To make a self-test of the navigator:

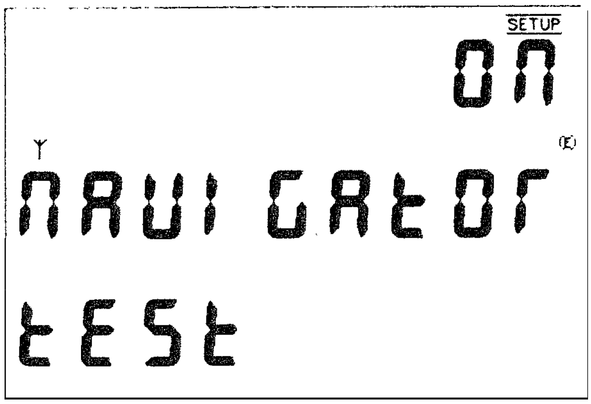
1. Select SETUP.



2. Select the "OFF NAVIGATOR TEST" display, by pressing the up or down key.
3. Press the E-key.
   "OFF" *is* flashing.

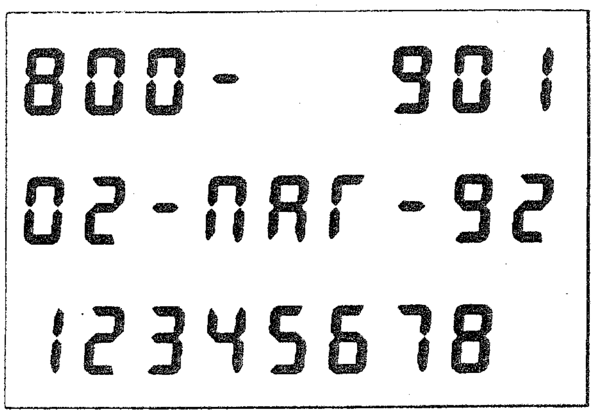


4. Use the **up** or down **key** to activale the function ("ON").
5. Press the E-key to start the self-**test.**

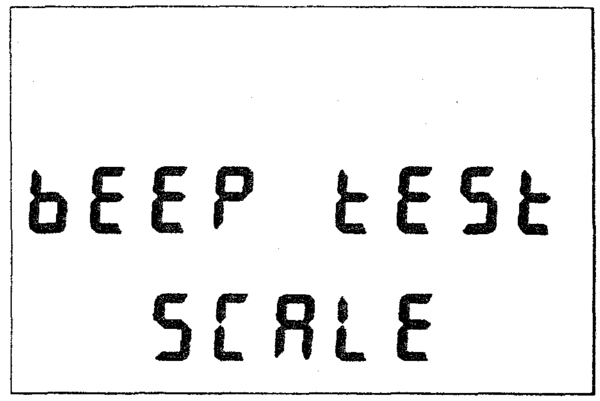


6. After the E-key has been pressed, the following displays will be shown:

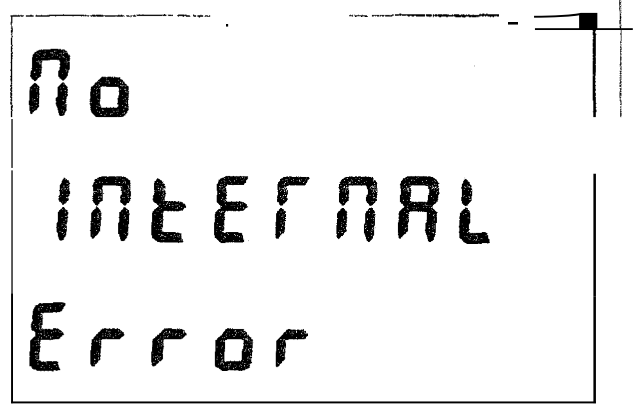
- Software release number.
- Software release date.
- Serial number.



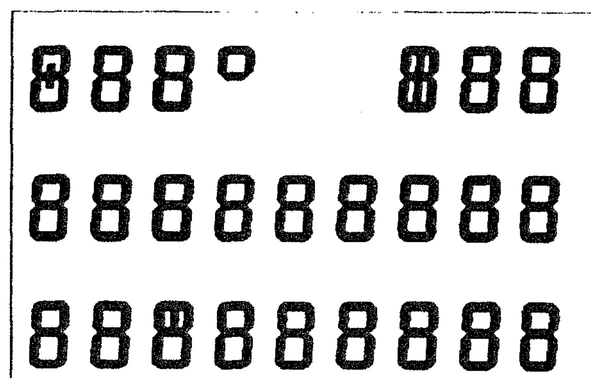
- **Bleep test** will **sound**



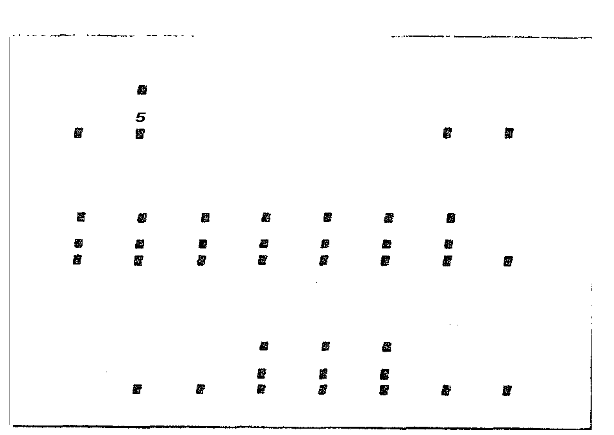
- **If** no **errors are found** this **will be displayed.**
- **if an error code is displayed, note the** number **and** contact your **service dealer.**



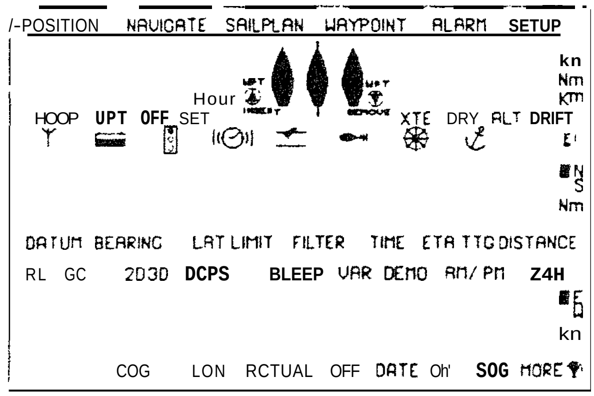
- Display **numeric** test.



- Display **dot** test.



- Display symbol test,.

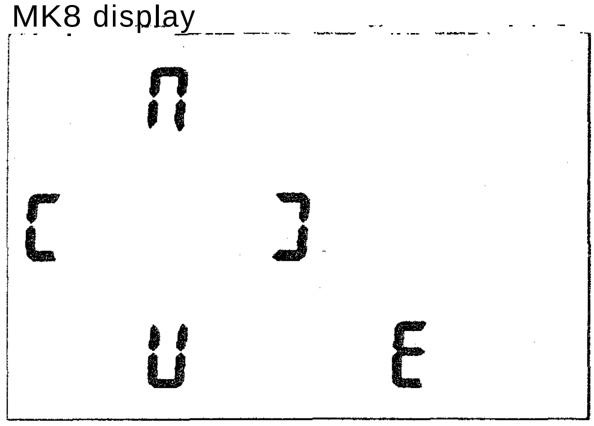


7. Key **board** test.
   5 or 9 symbols appear on the display.
8. Press the UP key and the UP symbol will stop flashing.
9. **Press** the LEFT key **and** the LEFT symbol will stop flashing.
10. Press the remaining **keys** and the rest *of* the symbols will stop flashing.

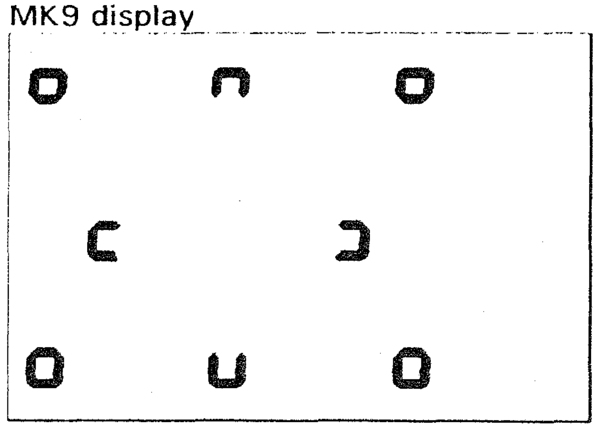
- If all symbols have stopped flashing the keyboard is ok, and the display will change to the one shown below.

- **If** you can not make one or more of the symbols stop flashing by pressing the corresponding keys, you should contact your service dealer reporting the **key** board error.

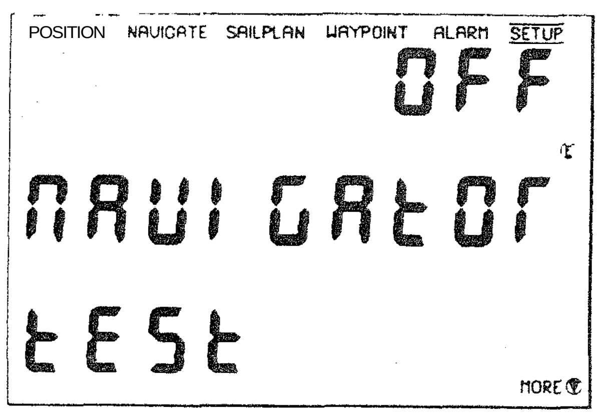
MK8 display



MK9 display



11. When the navigator has finished the self test it returns to normal mode.

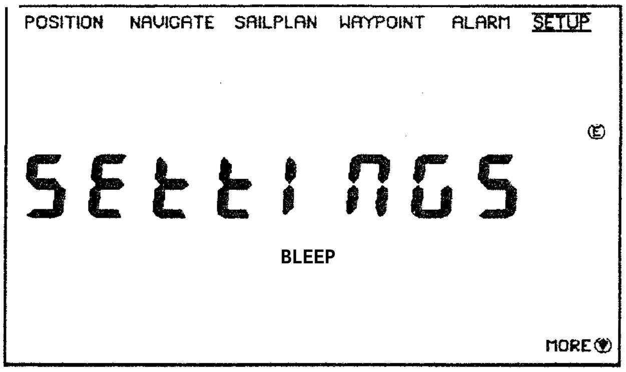


Signal quality control.

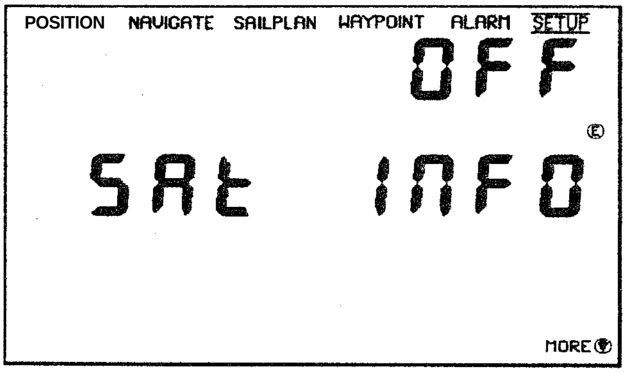
To **check the signal quality,** you **can monitor the signal/noise** ratio in POSITION.
The following example describes how:

1. **If SAT INFO is** ON, **in** SETUP, **jump to point number *7*.**

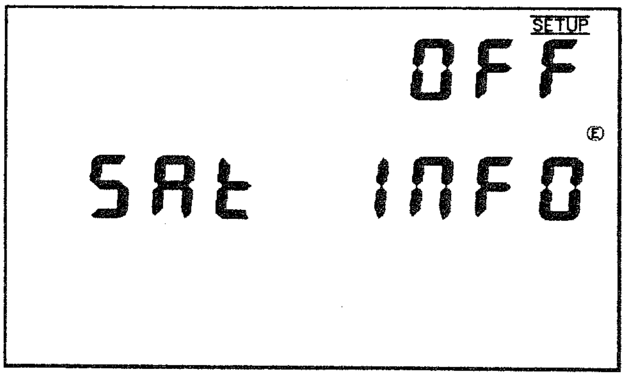
2. **Select SETUP.**



3. **Scroll up or down with the arrow keys to select the SAT** INFO **display.**

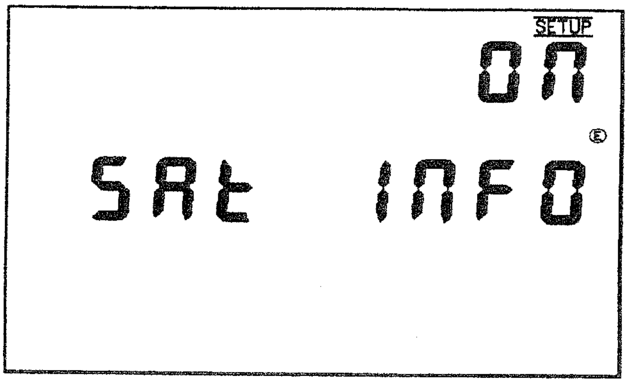


4. **Press the** E- **key: OFF is flashing.**

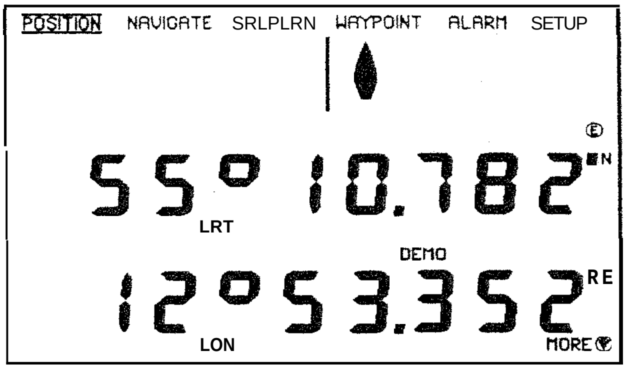


5. Press the up or down arrow key to select ON.

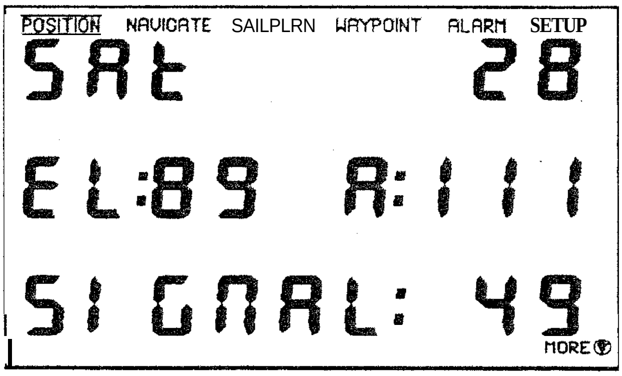
6. Press the E-key to exit.



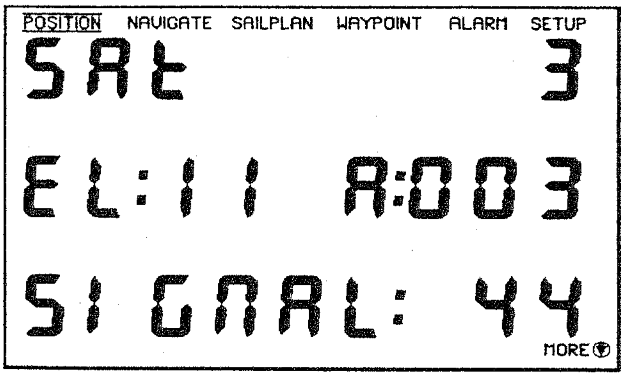
7. Select POSITION.



8. Scroll up or down with the arrow keys to select the SATELLITE INFORMATION **display.** SATellite **number,** ELevation over horizon, Azimuth from true North **and** SIGNAL/noise ratio.



9. Press the up or down arrow key **to** see the other displays, there are 6, one for each channel.



Note: The signal/noise ratio should on open sea be minimum 40 if the ELevation is above 30 (degrees). If this is not the case, the navigator may have a bad antenna, cable connection or a defective antenna.

Maintenance

The navigator **is** almost maintenance free. There **is,** however, a few important points to be noted.

Backup Battery.

The internal real time clock and memory that keeps track of waypoints, alarm limits etc **is** backed up by a lithium cell battery (Type CR 2032, 3V). Expected life time is 2 years.

Replacement of Backup Battery.

Be sure to have the new battery at hand. Suppliers will typical **be** your marine electronics dealer **or** a radio **shop.**

The battery **is** placed at the back of the navigator unit (see figure 7). It is an advantage to have or just have had power on the unit (for 5 minutes), before the battery **is** changed. This will give about three times the normal 50 seconds to make the change:

1. Dismount the navigator.
2. Dismount the D-SUB and antenna cable if necessary to get to the **back** of the navigator.
3. Remove the battery rubber **lid** from the back of the navigator using a coin or a blunt instrument.
4. Remove the old battery.
5. **You will have at least 50 seconds to insert the new battery without loosing the contents of the memory.**
6. Insert the new battery **checking the right polarity.** Use a pair of plastic tweezers, a rubber clove, a clear thin plastic back or a similar tool to replace the battery. Do not use your fingers directly on the battery. Grease from fingers might reduce the lifetime of the battery severely.
7. Replace the rubber **lid.**
8. Connect the cables (if dismounted).
9. Remount the navigator.

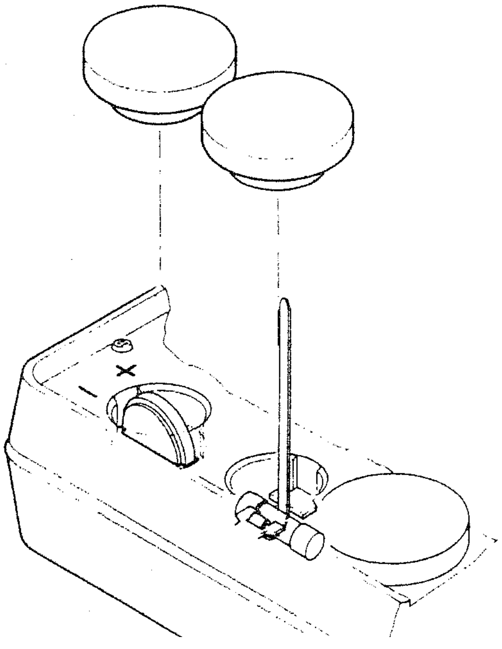


Figure 7.

Replacement of Fuse.

The navigator has an internal fuse to protect the electronic from overvoltage **or** wrong polarity.

A 1.25 **A** fast blow 05mm by 20mm must be used. Suppliers will typical be your marine electronic dealer or **a** radio shop.

The fuse is placed at the back of the navigator unit (see figure 7). You must disconnect the power cable before installing the replacement fuse. **Also** please check the polarity and voltage - in order to find the cause of the blown fuse before reinstalling the navigator.

1. Dismount the navigator.
2. Dismount the **D-SUB** and antenna cable.
3. Remove the fuse rubber lid from the back of the navigator using a coin or a blunt instrument.
4. Remove the old fuse pulling the nylon strip.
5. Inspect the old fuse to test if it is blown. (If not check the power cable installation).
6. Place the new fuse in the fuse socket. Be sure to get the nylon strip underneath the fuse in order to be able to remove the fuse next time.
7. Replace the rubber lid.
8. Connect the cables.
9. Remount the navigator.

Cleaning.

Use a fresh clean soft cloth for cleaning. **Do not** clean with alcohol or any other **solvent** as it will destroy the clarity of the display window.

Salt deposits on the antenna should be removed at regular intervals using clean fresh water.

Software Up-date

Your navigator is an advanced piece of electronics. The many functions and features are designed to fulfil most, if not all, of the demands you may have as a yachtsman.

We receive, however, many suggestions from a variety of users for new, changed or extended features. This information combined with the skill of our development engineers (of which most are keen yachtsmen) gives us the possibility of updating the software that controls the navigator.

The **Philips navigator** products have always been on the forefront when it comes to yacht navigation. This **GPS** navigator *is* no exception.

The navigator is designed so that the control software can be changed or updated without even opening the housing, When new software versions become available, just **bring** your navigator to the authorized dealer. He will make the upgrade in a matter of minutes.

If new software features (e.g. Differential GPS for MK8) become available, you will be notified through the boating press or directly from your dealer.

The software updates will be available for a nominal fee.

Technical Data

Technology

Navigator:		
Receiver:		6 channels parallel continues tracking.
Display:	Type:	Transparent STN Liquid Crystal.
	Multiplexed:	8:1
	Back light:	Yellow LEDs.
	Protection:	Acryl 7N PMMA window.
Key board:		Embossed membrane switch (5 keys).
Text Foil:		Polycarbonate.
Plastic enclosure:		ABS/PC-blend Cycoloy C1200.
Data Connector:		9 pin (male) D-SUB.
Antenna Connector:		F, female (for RG59).
Antenna:		
Type:		Patch with build in preamplifier.
Ground plane:		Not needed.
Connector:		Depending of type of antenna.
Material:		Depending of type of antenna.
Antenna Cable:		
Type:		SAT4S or RG59.
Connectors:	Navigator end:	F, male twist on (for RG59)
	Antenna end:	TNC male.
Data Cable:		
Type:	Power:	Joint pair 0.75 mm^2
	NMEA talker:	Shielded pair 0.10 mm^2
	MK9 cable only:	
	NMEA listener:	Shielded pair 0.10 mm^2
	MOB:	Joint pair 0.20 mm^2
Connector:		9 socket (female) D-SUB.

Physical Characteristics

Navigator:	
Height:	127 mm
Width:	222 mm
Depth mounted:	40 mm to wall
Depth flush mounted:	23 mm to wall
Depth overall:	75 mm
Weight:	680 g
Mounting stay length:	45 mm (34mm free), 6 mm thread.
Antenna:	
Length:	Depending of type of antenna.
Width:	Depending of type of antenna.
Depth mounted:	Depending of type of antenna.
Depth overall:	Depending of type of antenna.
Weight:	Depending of type of antenna.
Antenna Cable:	
Diameter:	Ø 6 mm, 0.50 mm^2 solid core.
tength:	14 m

All specifications and accessories are subject to change without prior notice

Data Cable:

Length:	Power:	6 m
	NMEA:	2 m
	MOB:	6 m (MK9 only)

Environmental

Navigator:

Operating temperature range:	-0°C to +50°C
Ambient conditions:	Splash proof (when mounted correctly).

Antenna:

Operating temperature range:	-10°C to +70°C
Ambient conditions:	Marine, waterproof.

Cables:

Operating temperature range:	-10°C to +70°C
Ambient conditions:	Marine.
Bends:	Minimum radius 50 mm for antenna cable.

All:

Storage temperature r nge:	-20°C to 70°C
Relative humidity:	95%
Vibrations:	MPT 1204/11 FTZ 171 R47 CEPT TR 34-01 IEC
Compass safe distanc	Recommended 0.5 m

Power & inputs/outputs

Navigator:

Power:	Type:	DC/DC switch mode with galvanic separation.
	Consumption:	Less than 5 W (display back light on).
Supply voltage:		12 or 24 volt battery: 9.6 VDC to 32 VDC.
Reverse protection:		At 0.7 V: Fuse.
Overvoltage protection:		At 40 V: Fuse.
Isolation:		Supply voltage to data pins or shield: Max 50 VDC.
NMEA talker (output):		Meets NMEA 183 version 2.0
	voltage:	max ±6 V, min ±2 V
	current:	max 18 mA
NMEA listener (input):		Meets NMEA 183 version 2.0
	isolation:	opto coupler.
	input impedance:	500Ω
	threshold:	max 2 V / 2 mA
	max voltage:	±15 V
MOB:	Reference:	REF GND.
	input impedance:	50 K Ohm to 100 K Ohm: internal pull up to 5 V.
	Activated:	Short-circuited to REF GND (contact closure).
	Max voltage:	±25 V
Backup:	Type	Lithium battery 3.2 V # CR 2032.
	Life:	Minimum 2 years.
	Replacing:	From the back of the navigator.

	Battery change:	Time for **battery** change *is* minimum 50 seconds without **loss** of data.
Fuse:	Value:	**1.25 Amp fast blow.**
	Size:	**Ø** 5 mm **by** 20 mm.
	Replacing:	From the back of the navigator.

Antenna:

Power Consumption:		0.1W supplied by the navigator through the antenna cable.
Supply voltage:		**5.5** VDC
Amplifier:	Gain:	12 dB at 1575.42 MHz
	Noise figure:	2.5 dB

Program functions

Navigator:

Displays:

Position:	Latitude, Longitude (& Altitude) Time Satellite status
Navigate:	Course Over Ground Speed Over Ground **Cross** Track Error (XTE) Bearing to next waypoint Distance to next waypoint Time To GO Estimated Time of Arrival
Sailplan:	One sailplan with up to 100 waypoints
Waypoints:	100 (0 to 99)
Alarms:	Antenna open/shorted Battery low voltage **Position** no update Waypoint approach Autopilot Anchor Time (8) Man Over Board (MOB)

NMEA 183 talker sentences:

Version 2.0:	APB, BWR, BWC, RMB, RMC, VTG and XTE.
Version 1.5:	APA, GLL and SNU.

NMEA 183 listener sentences:

Version 2.0 & 1.5: WPL.

Update:	Display:	Every second.
	NMEA sentences:	Every two seconds.

Automatic initialization

The navigator has an automatic position initialization which will always result in the correct position. It is not possible to enter an estimated time or position into the navigator. If the navigator has been moved more than a few hundred nautical miles without tracking satellites, the navigator will start to search for the correct position after approximately 30 minutes.

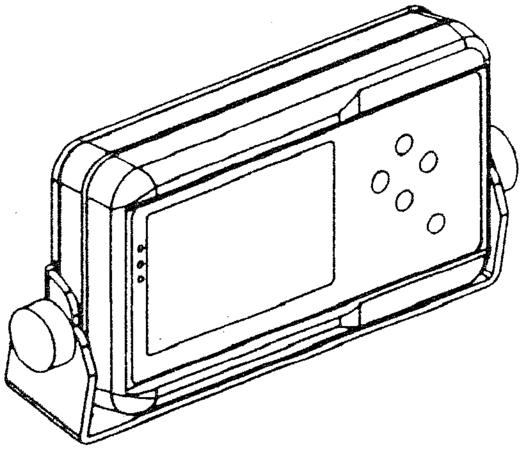
Equipment

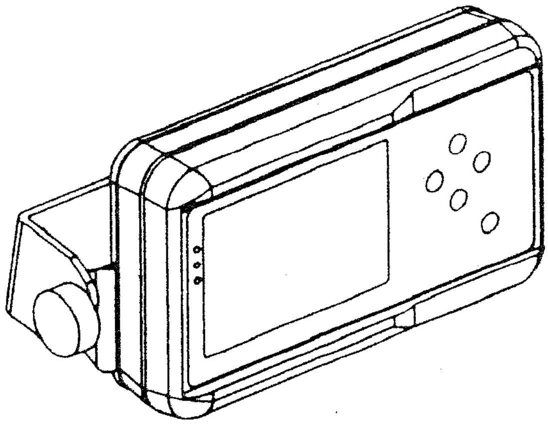
Standard:

Navigator unit
Drilling template
Navigator mounting stays and nuts
Supply and interface cable
Backup battery cell
Users manual
Technical manual (this booklet)
Patch Antenna
Antenna cable
Antenna mounting bracket, screws and nuts
Antenna mounting instruction

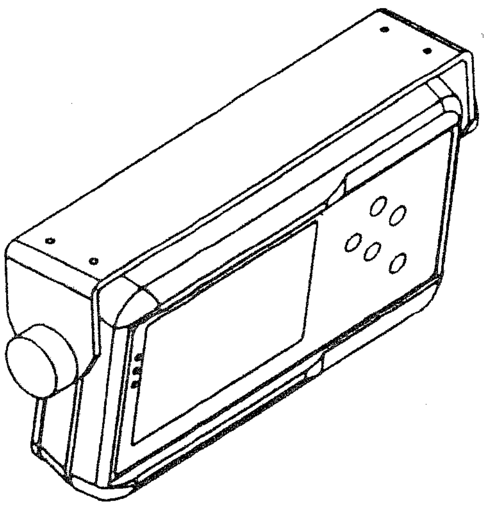
Optional:

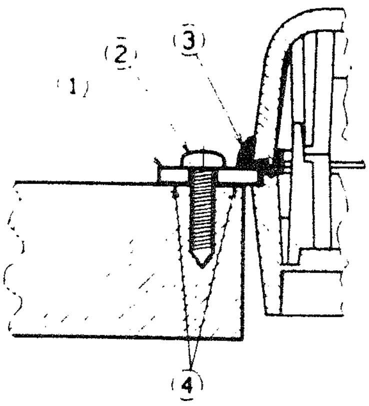
Mounting Bracket for below deck installation:
Part No. 9525 200 70710





Flush Mounting Kit for above or below
deck mounting:
Part No. 9525 200 70700





1. Flush mounting frame.
2. 10 pcs. screw.
3. Red rubber seal.
4. Silicone grease (optional).

Antenna for flush mounting on ground plane
(min. area 800 cm^2):
Part No. 9525 200 08980

International Service

Australia
Coursemaster Autopilots
7 Smith Street
Chatswood, N.S.W. 2067
Tel: +61 29 417 7097
Fax: +62 29 417 7557

Belgium
See Holland

Denmark
Leica Geosystems A/S
AP Navigation
Hørkær **12A**
DK-2730 Herlev
Tel: +45 44 54 03 24
Fax: +45 44 94 43 96

Finland
NAVIDEC OY
Hernesaarenranta 13
PL 326 FIN-00151 Helsinki
Tel: +358 9 7001 7780
Fax: +358 9 179 830

France
Furuno France S.A.
Parc Technologigue Carnot
20 Avenue Edouard Herriot
F-92356 Le Plessis Robinson Cedex
Tel: +33 1 46 29 94 29
Fax: +33 1 40 94 08 45

Germany
NAVICO DEUTCHLAND GmbH
Lollfuss 43-45
D-24837 Schleswig
Tel: +49 4621 9613-0
Fax: +49 4621 9613-28

Great Britain
Comar Service Ltd.
Unit 3, Medina Court
Arctic Road, Cowes PO 31 7XD
Isle Of Wight
Tel: +44 1983 282400
Fax: +44 1983 280402

Greece
Selmar Electronics Ltd.
12-14 Gain. Tzelepi
GR-18531 Piraeus
Tel: +30 14 11 95 85-7
Fax: +30 14 11 95 88
Tlx: 241 892

Holland
Sailtron **B.V.**
Postbus 5044
NL-3502 **JA** Utrecht
Tel: +31 302 94 47 41
Fax: +31 302 93 76 42
Tlx: 40 526

Hong Kong
Radio Holland Group
806 Join-In Hang Sing Centre
71 - *75* Container Port Road
Kwai Chung, N.T.
Tel: +852 422 39 007
Fax: +852 482 05 898
Tlx: 50881

Iceland
Elcon HF
Grandagardi 18
IS-127 Reykjavik
Tel: +354 5 61 95 10
Fax: +354 5 61 82 81

Ireland
See Great **Britain**

Italy
Messree MERCATORE srl.
P.O. **Box** 36
Porto Turistico
I-16043 Chiavari (GE)
Tel: +39 185 31 26 08
Fax: +39 185 32 27 31

Norway
ProNav as
Langholmen P.O. **Box** 421
N-4370 Egersund
Tel: +47 51 49 43 00
Fax: +47 51 49 21 00

Portugal
Soc. Corn. Crocker Delaforce
& Ca Lda
Rua D. Joao V, 2 - 2nd
P-1200 Lisboa
Tel: +351 13 88 01 41
Fax: +351 138827 11

International Service

South Africa
Decca Contractors **S.A.** Pty. Ltd.
1 & 2 Enslin Road
Ottery 7800, Cape
Tlf: +27 21 70 **41** 600
Fax: +27 21 70 41 610

Spain
C.R.A.M.E. **SA**
C/San Severo 30
"Barajas Park"
E-28042 Madrid
Tel: +34 13 29 18 62
Fax: +34 13 29 30 46

Sitelsa S.A.
Via Augusta, 186
ES-08021 Barcelona
Tel: +34 34 1401 92
Fax: +34 34 14 25 33

Sweden
Sportmanship Marin **AB**
Bolshedens Industrivaeg 30
S-427 22 Billdal
Ttf: +46 31 93 94 00
Fax: +46 31 91 32 31

Switzerland
Bucher & Walt
Route De Soleure 8
CH2071 St. Blaise
Tel: +41 38 35 95 00
Fax: +41 38 35 95 30

Turkey
Beyoglu, Gumussuyu
Bolahenk Sok. **No.**11
Taksim Istanbul
Tel: +90 21 22 39 10 29
+90 21 22 93 28 31
Fax: +90 21 22 **43** 61 25

All warranty service is carried out in accordance with terms and conditions applicable in the country of purchase.

Glossary of Terms

ALARM
Message by which the navigator signals the occurrence of an event. The alarm is indicated by an audible tone and a message (or icon) on the display.

ALMANAC
Library of coarse satellite orbital characteristics used to calculate satellite rise times, set times, angles of elevation etc. Almanac data is valid for several months.

ALTITUDE
The height of the navigator over mean sea (taking into account the ANTENNA HEIGHT as stated in SETUP, in the User Manual).

ANTENNA HEIGHT
The height (over the water line) in which the antenna is installed.

AZIMUTH
In satellite navigation, the angular distance measured on the horizon circle in a clockwise direction from the north point in the horizon to the satellite point in the horizon.

BEARING
The direction of one terrestrial point from another, expressed as angular distance from north clockwise through 360 .

COG
See COURSE OVER GROUND

COMFASS HEADING
Compass reading before correction for deviation and variation.

COURSE
The horizontal direction in which a vessel *is* steered or intended to be steered, expressed as angular distance from north clockwise through 360. (Strictly the term **applies** to direction through the water, not the direction intended to be made good over the ground). The course is often designated as **true, magnetic**, or **compass** as the reference direction **is** true, magnetic, or compass, respectively.

COURSE LINE
A line, as drawn on a chart, extending in the direction of a course (rhumb line).

COURSE OVER GROUND
Course made good relative to the sea bed.

GROSS TRACK ERROR (XTE)
The perpendicular distance from the vessel to the actual course line (track) as defined in the Sailplan.

DATUM
The framework on which the coordinates used to define position on the earth's surface is based. In the navigator, a datum shift relative to WGS 84 is defined by the following parameters:

A and F	Size and shape of a reference ellipsoid.
▲X, ▲Y, ▲Z	Position of the reference ellipsoid origin in relation to the satellite datum ellipsoid origin.

EDIT
To modify existing display data via the keyboard.

ELEVATION ANGLE
The angle made by the line-of-sight range to the satellite and the horizontal plane of the navigator. Thus, the elevation angle is 90 degrees when the satellite is overhead and 0 degrees when the satellite first appears on the horizon. Satellites whose elevation angle is less than 3 degrees are not good candidates for providing an accurate position (latitude and longitude) update.

ENTER
To store data in the memory of the navigator.

ETA
Estimated Time of Arrival. Calculated on basis of the distance to the destination and the actual (present) speed.

FILTER TIME
If the GPS signals are distorted by Selective Availability (S/A) the COG and SOG readings will be unstable, especially at low speeds. In order to smoothen out the readings you can activate the FILTER TIME feature.

With FILTER TIME set to 0 (zero) minutes the navigator will have the dynamics adjusted to yachting purposes. With S/A active additional filtering may be needed. The averaging time can be increased to 1 through 19 minutes. The optimal value depends on the characteristics of the S/A and your navigational needs. 10 minutes may be a good starting point.

FUNCTION
A specific operational capability of the navigator.

GLOBAL POSITIONING SYSTEM, GPS
The NAVSTAR Global Positioning System which consists of orbiting satellites, a network of ground control stations, and user positioning and navigation equipment. When fully operational, the system will have 21 plus 3 active spare satellites in six orbital planes about 20,200 kilometres above the earth.

GREAT CIRCLE NAVIGATION
Navigation based on Great Circle. The advantage of Great Circle navigation is that it brings you the shortest way through the sailplan. The disadvantage is that a Great Circle track may differ from the straight rhumb line that is easily drawn on a Mercator projected chart. Great Circle navigation is recommended for ocean voyages only. The advantage increases by higher latitude (north or south). It is biggest on an east/west course and zero on a north/south course.

HDOP
Horizontal Dilution Of Precision. An indicator of the two dimensional accuracy in position (latitude and longitude). Converted to metres it is theoretically HDOP x 10 when S/A is off.

INTERFACE
Electronic circuits that permit the passage of data between different types of devices.

LATITUDE
The perimeter of a parallel plane in the earth's ellipsoid. The parallels define latitude. A special case parallel is the equator whose latitude is 0 degrees and to which all other parallels are referenced.

LEG
One of the stages in a sailplan.

LOCAL TIME ZONE
The time zone (see TIME ZONE) in which the navigator is located

LOCAL TIME ZONE OFFSET
The number of hours by which the local time zone differs from Universal Time Coordinated.

LONGITUDE
The circumference line of a meridian plane. The meridians define longitude. A special case meridian is the Greenwich meridian whose longitude is 0 degrees and to which all other meridians are referenced.

MAGNETIC HEADING
Direction as sensed by the steering compass in relation to magnetic north.

MAGNETIC NORTH
Direction in the plane of the observer's horizon toward the earth's north magnetic pole.

MAGNETIC VARIATION
The angle by which magnetic north deviates from true north at any given point on the earth's surface.

MERCATOR CHART
A map developed by Mercator projection wherein the curved surface of the earth's ellipsoid is projected onto a cylinder and the cylinder is "unwrapped" to form a flat representation of the ellipsoid (earth model).

NMEA
National Marine Electronics Association. The NMEA electronics interface specifications have been developed under the auspices of the Association. The NMEA 0183 is an internationally recognized specifications for interfacing marine electronics.

OFF TRACK
See CROSS TRACK ERROR

POSITION UPDATE
The recalculation of position by analysis of satellite orbital data as referenced to time.

RHUMB LINE
The course of a vessel that keeps a constant direction drawn as a line on a chart or globe and cutting across all meridians at the same angle. A rhurnb line is a straight line on a mercator chart.

RHUMB LINE NAVIGATION
Navigation based on rhumb lines. See also GREAT CIRCLE NAVIGATION.

S/A
See SELECTIVE AVAILABILITY

SAILPLAN
The sailplan is a sequential list of waypoints describing the planned voyage. It is in other words the "active route" to follow.

SATELLITE SIGNAL
Transmitted electromagnetic energy from a GPS satellite whose time of arrival is measured by the navigator to calculate the position of the navigator antenna.

SELECTIVE AVAILABILITY (S/A)
A system whereby the accuracy of GPS is reduced. S/A is controlled by the U.S. Department of Defense.

S/N (SIGNAL-TO-NOISE RATIO)
Quantitative relationship between the useful and non-useful part of the received satellite signal. A high S/N indicates a good signal strength.

SOFTWARE
Values programmed and loaded into memory. The values represent a permanent set of instructions for running the automatic functions (computations) of the navigator.

SOG - SPEED OVER GROUND
Speed in relation to the sea bed.

STEERING COMPASS
The compass used for navigation.

TIME OFFSET
The number of hours by which the time zone differs from Universal Time Coordinated (UTC).

TIME ZONE
One of the 24 longitudinal segments around the world, each generally 15 degrees and 1 hour wide. In some regions there are half-hour time zones.

TRUE HEADING
Direction in relation to true north. True heading is compass heading corrected for MAGNETIC VARIATION and deviation.

TRUE NORTH
Direction along the meridian of the observer to the north pole.

UNIVERSAL TIME COORDINATED
(UTC) Greenwich mean time corrected for polar motion of the earth and seasonal variation in the earth's rotation.

UPDATE
See POSITION UPDATE.

WAYPOINT
A point, usually along the planned track of the vessel whose position coordinates may be stored in the navigator. The?point position is the basis of the heading, range, heading-to-steer, estimated time of arrival and steering display calculations.

WORLD GEODETIC SYSTEM (WGS)
Worldwide datums (WGS 72 and WGS 84) used for satellite navigation systems. For all practical purposes the two datums may be considered identical You may thus use the WGS72 offset figures from the chart in the navigators WGS84 Plus Offset datum (00). All charts will eventually be converted to WGS 84 datum.

X-TRACK ERROR
See CROSS TRACK ERROR.

About GPS

GPS (the Global Positioning System) represents the state of the art in precise, continuous, worldwide satellite navigation.

The constellation of satellites will ultimately consist of 24 operational satellites (21 plus 3 operating spares). The US Department of Defense (DOD) will declare the GPS constellation fully operational when 21 operational (Block II) satellites are functioning in their assigned orbits. This is expected to occur in 1993. Users are cautioned that the system is under development, and signal availability and accuracy are subject to change without warning at the discretion of the DOD. Therefore, until the system is declared Operational, any use of the system **is** at the user's own **risk.**

GPS will provide two levels of service - a Standard Positioning Service (SPS) and a Precise Positioning Service (PPS).

SPS is a positioning service which will **be** available to all GPS users on a continuous, worldwide basis with no direct charge. **SPS** will be provided on the GPS L1 frequency which contains **a** course acquisition (C/A) code and a navigation data message. SPS is planned to provide the capability to obtain horizontal position accuracy within 100 meters 2drms (95 percent probability) and *300* meters 99.99 percent probability. The GPS L1 frequency also contains a precision (P) code, that is not part of the SPS.

PPS is a highly accuracy military positioning service that will not **be** publicly available.

The SPS accuracy is a result of a degradation of the basic GPS accuracy, caused by a cryptographic technique called selective availability (S/A). Without S/A the typical horizontal accuracy is found in the range 15 to *30* meters 2drms.

Unlike Decca and Loran-C navigators, the geographical accuracy and the position repeatability are identical for GPS navigators.

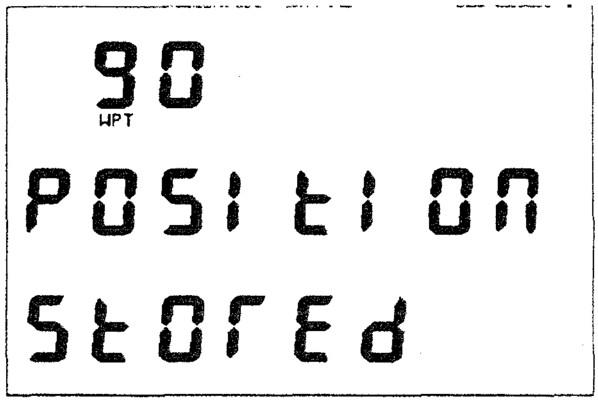
There is at present no information in the GPS signals telling the civilian user whether **S/A** is used or not. However, if your boat is moored, and the navigator shows a steady Course Over Ground and (low) Speed Over Ground, you may expect that **S/A** is in use.

Position Store

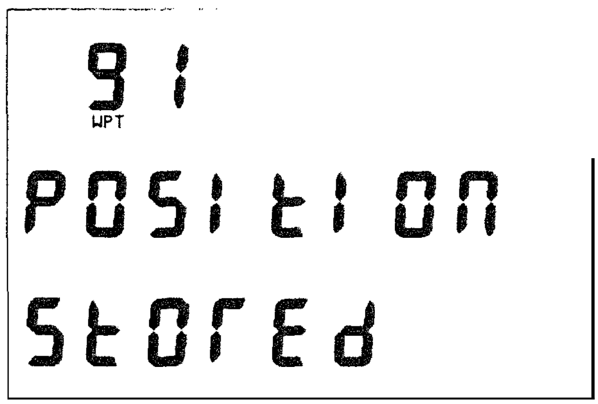
The navigator **offers** a POSITION STORE (MARK) feature. Waypoints 90 through 98 are reserved for this purpose.

Store the present position **as a way-**point:

1. Press the MO5 button briefly (less than 2 seconds). The latitude and longitude of the present position are now stored in the navigator. The number of the waypoint will be displayed for a few seconds (e.g. number 90).

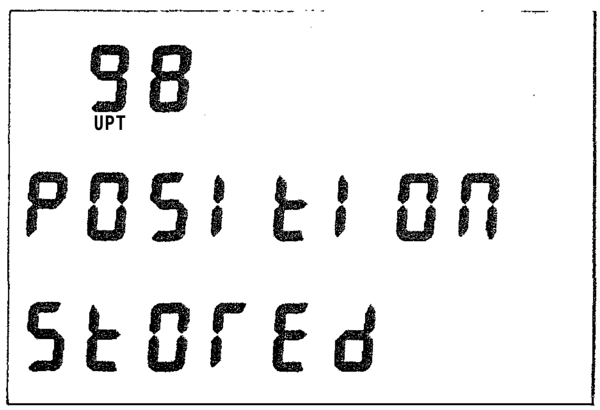


2. The next time the button **is** pressed the new position **is** stored in the next waypoint location (here number 91).



3. Each time the button in pressed the position **is** stored in the next waypoint location until waypoint 98 has been used. The navigator will then start with waypoint 90 again.

4. Each **time** a position is stored. the old (existing) data are overwritten. If you intend to keep the new way-points, they should be moved to **a** 'safe' waypoint location (Nos. 1 through 89).



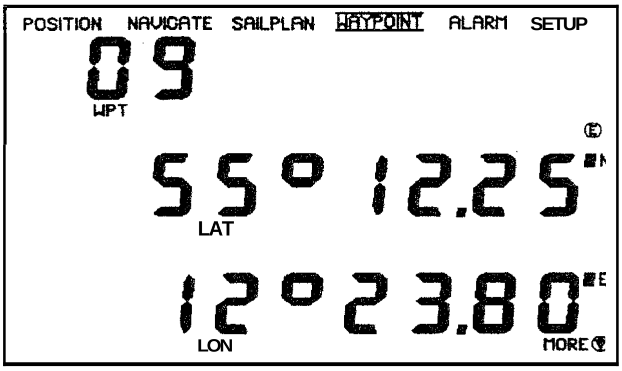
Alarm Acknowledge

Alarms may be acknowledged by a short press of the MOB button.

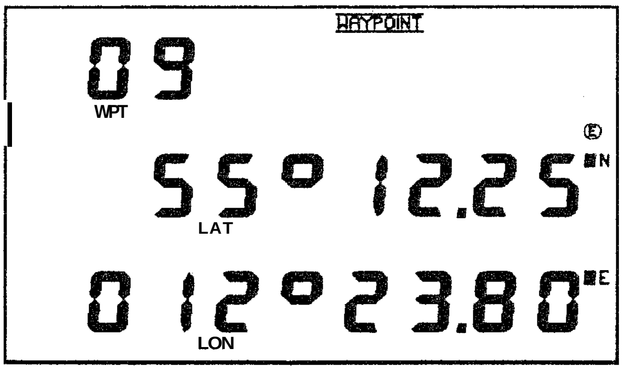
Fast access to waypoints in the waypoint bank.

Instead of scrolling through the waypoint bank (for instance from WPT no 9 to 56) you can choose to make a short cut by editing in the waypoint number. The following example describes how:

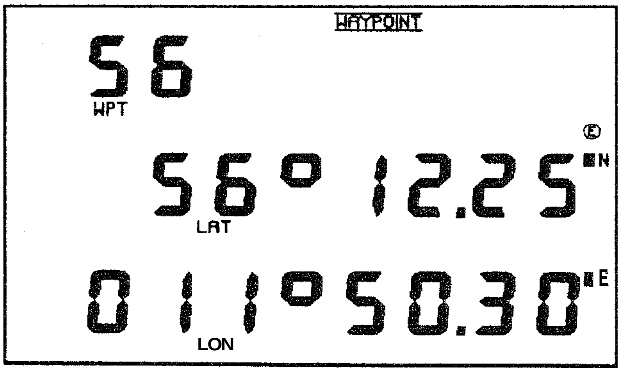
1. Select WAYPQINT.



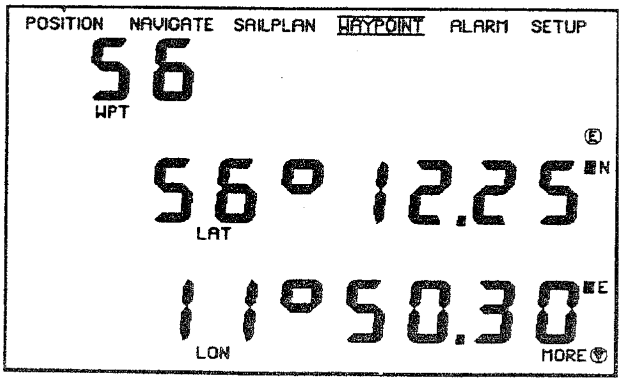
2. Press the E-key. The fir t digit in LAT is flashing.
3. Press the left arrow key. Now the last digit in WPT is flashing.



4. Use the **up** or down arrow key to change the last digit of the waypoint number.
5. Press the left arrow key. The first digit in WPT is flashing.
6. Use the **up** or down arrow key to change the **digit.**



7. Press the E-key to **exit.**

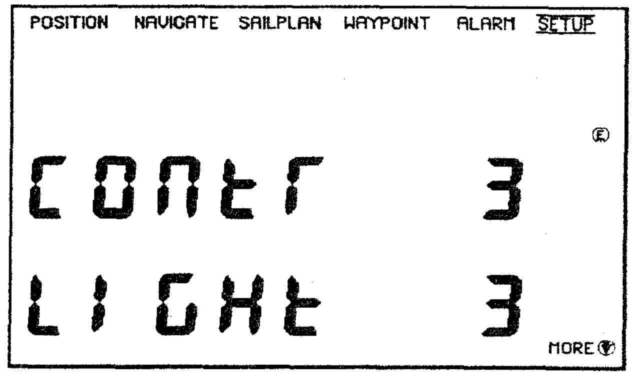


Contrast and Back Light setting.

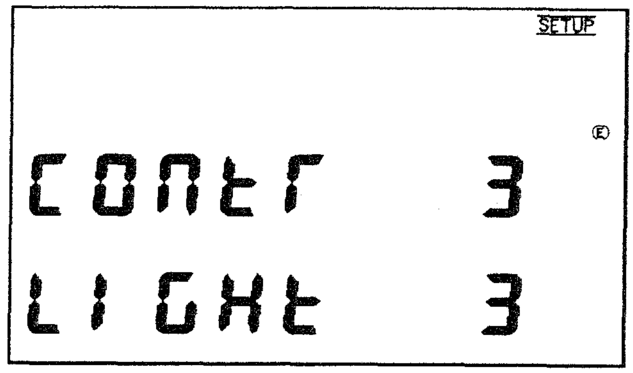
At sunset and sunrise respectively, the backlight is switched ON **and** OFF automatically. The contrast and back light of the display can be changed to accommodate different viewing conditions. The following example describes how:

1. Select SETUP.

2. Scroll up or down with the arrow keys to the CONTR/LIGHT **display.**



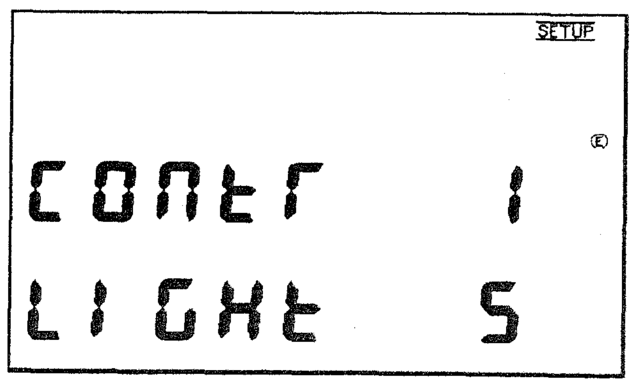
3. Press the E-key:
   First digit (CONTRast) is flashing.



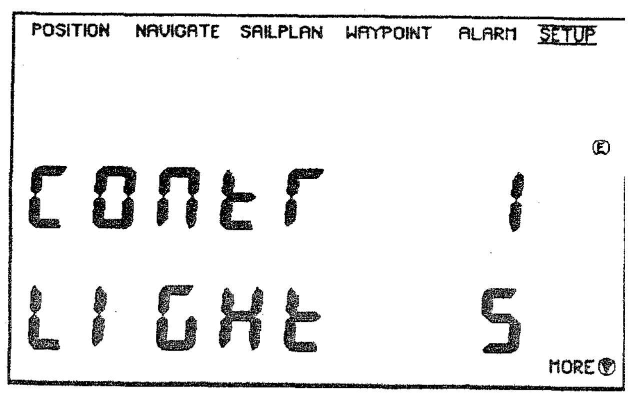
4. Press the up **or down** key and the contrast of the display will change.
   The CONTRAST can be set on a **scale** of 1 through 5.

5. Press **the left or right** key to select LIGHT.

6. Change the back light in the same way as described in 4.



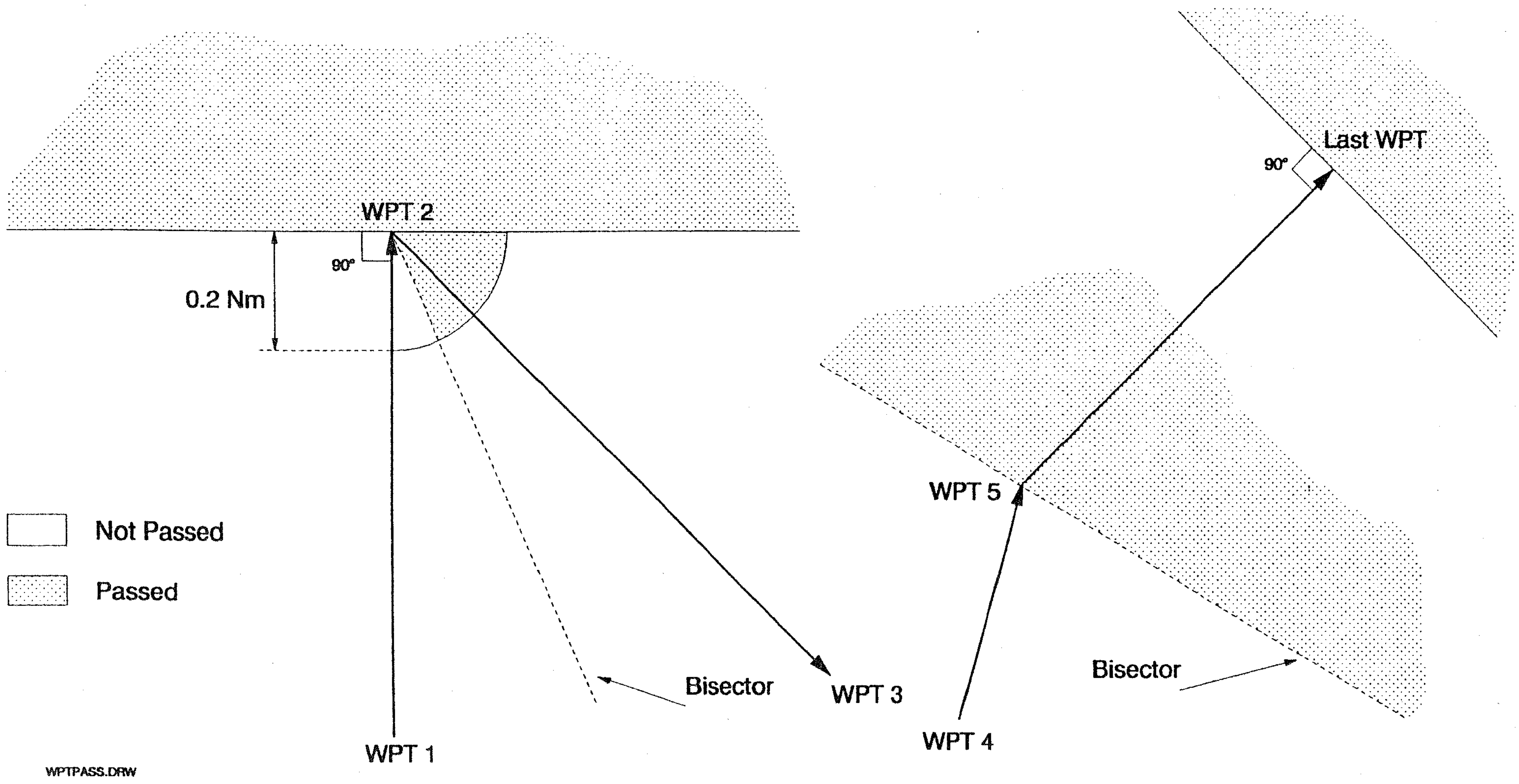
7. Press the E-key to exit.



Waypoint Pass Criteria - Complex

Pass Criteria for Acute Angles (≤90°) between Waypoint Legs

Pass Criteria for Obtuse Angles (>90°) between Waypoint Legs



Waypoint List

WPT No.	Latitude	Longitude	Name/Description	Datum
01				
02				
03				
04				
05				
06				
07				
08				
09				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				
24				
25				

Waypoint List

WPT No.	Latitude	Longitude	Name/Description	Datum
26				
27				
28				
29				
30				
31				
32				
33				
34				
35				
36				
37				
38				
39				
40				
41				
42				
43				
44				
45				
46				
47				
48				
49				
50				

Waypoint List

WPT No.	Latitude	Longitude	Name/Description	Datum
51				
52				
53				
54				
55				
56				
57				
58				
59				
60				
61				
62				
63				
64				
65				
66				
67				
68				
69				
70				
71				
72				
73				
74				
75				

Waypoint List

WPT No.	Latitude	Longitude	Name/Description	Datum
76				
77				
78				
79				
80				
81				
82				
83				
84				
85				
86				
87				
88				
89				
90				
91				
92				
93				
94				
95				
96				
97				
98				